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EXPERIMENTAL DETERMINATION OF THE CONSTANT IN THE FORMULA FOR PROBABLE ERROR.

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THE law of errors is expressed by eq. (4), ANALYST, page 51, Vol. VI, viz.;

$$\frac{\tan^{-1}cx}{\tan^{-1}c\,l} = \frac{z}{n}, \tag{4}$$

where z is the number of errors not greater than x, and n the number not greater than l, $S(d_1^2)$ = the sum of the squares of the errors, and

$$c = \sqrt{\frac{n}{S(d_1^2)}}.$$

Making $z \div n = \frac{1}{2}$, gives $x = \surd[S(d_1^2) \div n] \tan \frac{1}{2} \tan^{-1} cl$. It is required to find the numerical value of $\tan \frac{1}{2} \tan^{-1} cl$.

The following 80 numerical values of a quantity were observed by me: 34, 30, 40, 38, 36, 33, 32, 33, 38, 36, 32, 34, 32, 33, 32, 34, 34, 33, 32, 33, 33, 33, 40, 33, 34, 32, 44, 41, 40, 32, 32, 41, 34, 31, 31, 40, 33, 40, 34, 33, 38, 38, 40, 34, 38, 35, 40, 35, 39, 38, 40, 32, 36, 34, 35, 34, 36, 34, 39, 38, 37, 35, 36, 38, 34, 35, 32, 34, 36, 35, 32, 34, 35, 32, 32, 36, 38, 36, 38, 36.

The true value of the observed quantity as determined by the method of Least Squares, which in this case coincides with the mean, is 35.6. Subtracting 35.6 from each of the above numbers gives the errors, of which the greatest is $8.4 = l$, and the sum of their squares is $729.96 = S(d_1^2)$, $\frac{80}{729.96} = c^2 = .109602$, $c = .33106$, $cl = 2.7809$, $\tan^{-1} cl$ = arc of $70° 13' 17''$, $\tan \frac{1}{2} \tan^{-1} cl = 35° 06' 38'' = .703$. In another case of 120 observed values of another quantity the calculated value was $36\frac{11}{15}$, the greatest observed error $5\frac{4}{15}$, $S(d_1^2)$ was found to be $408\frac{4}{15}$, and the resulting value of $\tan \frac{1}{2} \tan\, cl = .709$. I therefore conclude, from these two examples and others that I have examined that the true value of $\tan \frac{1}{2} \tan^{-1} cl$ is $.707 = \frac{1}{2}\surd 2$, and not .6745 as heretofore given.

Corollary. Since after a sufficient number of observations the value of l will cease to vary sensibly, $\surd[S(d_1^2) \div n]$ will have its limit also. Therefore I conclude that after this limit is reached, or nearly so, increasing the number of observations does not increase the accuracy of the result calculated from them. Prof. Peirce arrived at this conclusion in the Coast Survey Report for 1854.